

acid ionomers and has a Shore D hardness of 60 or greater and the outer cover layer comprised of polyurethane and has a Shore D hardness of about 45 (i.e., Shore C hardness of about 65).

5 It has been found that multi-layer golf balls having inner and outer cover layers exhibit higher C.O.R. values and have greater travel distance in comparison with balls made from a single cover layer. In addition, it has been found that use of a inner cover layer constructed of a blend of low acid (i.e., 16 weight percent acid or less) ionomer resins produces softer compression
10 and higher spin rates than inner cover layers constructed of high acid ionomer resins. This is compounded by the fact that the softer polyurethane outer layer adds to the desirable "feel" and high spin rate while maintaining respectable resiliency. The soft outer layer allows the cover to deform more during impact and increases the area of contact between the club face and the cover,
15 thereby imparting more spin on the ball. As a result, the soft polyurethane cover provides the ball with a balata-like feel and playability characteristics with improved distance and durability.

Consequently, the overall combination of inner and outer
20 cover layers made from blends of low acid ionomer resins and polyurethane results in a standard size or oversized golf ball having enhanced resilience (improved travel distance) and durability (i.e. cut resistance, etc.) characteristics while maintaining and in many instances, improving the balls playability
25 properties.

The combination of a low acid ionomer blend inner cover layer with a soft, relatively low modulus ionomer, polyurethane based elastomer outer cover layer provides for good overall coefficient of restitution (i.e., enhanced resilience) while at the same time demonstrating improved compression and spin. The outer cover layer generally contributes to a more desirable feel and spin, particularly at lower swing speeds with highly lofted clubs such as half wedge shots.

Two principal properties involved in golf ball performance are resilience and hardness. Resilience is determined by the coefficient of restitution (C.O.R.), the constant "e" which is the ratio of the relative velocity of two elastic spheres after direct impact to that before impact. As a result, the coefficient of restitution ("e") can vary from 0 to 1, with 1 being equivalent to an elastic collision and 0 being equivalent to an inelastic collision.

Resilience (C.O.R.), along with additional factors such as club head speed, angle of trajectory and ball configuration (i.e., dimple pattern) generally determine the distance a ball will travel when hit. Since club head speed and the angle of trajectory are factors not easily controllable by a manufacturer, factors of concern among manufacturers are the coefficient of restitution (C.O.R.) and the surface configuration of the ball.

The coefficient of restitution (C.O.R.) in solid core balls is a function of the composition of the molded core and of the cover. In balls containing a wound core (i.e., balls

comprising a liquid or solid center, elastic windings, and a cover), the coefficient of restitution is a function of not only the composition of the center and cover, but also the composition and tension of the elastomeric windings. Although both the core and the cover contribute to the coefficient of restitution, the present invention is directed to the enhanced coefficient of restitution (and thus travel distance) which is affected by the cover components.

In this regard, the coefficient of restitution of a golf ball is generally measured by propelling a ball at a given speed against a hard surface and measuring the ball's incoming and outgoing velocity electronically. As mentioned above, the coefficient of restitution is the ratio of the outgoing velocity to the incoming velocity. The coefficient of restitution must be carefully controlled in all commercial golf balls in order for the ball to be within the specifications regulated by the United States Golf Association (U.S.G.A.). Along this line, the U.S.G.A. standards indicate that a "regulation" ball cannot have an initial velocity (i.e., the speed off the club) exceeding 255 feet per second. Since the coefficient of restitution of a ball is related to the ball's initial velocity, it is highly desirable to produce a ball having sufficiently high coefficient of restitution to closely approach the U.S.G.A. limit on initial velocity, while having an ample degree of softness (i.e., hardness) to produce enhanced playability (i.e., spin, etc.).

The hardness of the ball is the second principal property involved in the performance of a golf ball. The hardness of the ball can affect the playability of the ball on striking and the sound or "click" produced. Hardness is determined by the deformation (i.e., compression) of the ball under various load conditions applied across the ball's diameter (i.e., the lower the compression value, the harder the material). As indicated in U.S. Patent No. 4,674,751, softer covers permit the accomplished golfer to impart proper spin. This is because the softer covers deform on impact significantly more than balls having "harder" ionomeric resin covers. As a result, the better player is allowed to impart fade, draw or backspin to the ball thereby enhancing playability. Such properties may be determined by various spin rate tests such as the "nine iron" spin rate test described below in the Examples.

Accordingly, the present invention is directed to an improved multi-layer cover which produces, upon molding each layer around a core (preferably a solid core) to formulate a multi-layer cover, a golf ball exhibiting enhanced distance (i.e., resilience) without adversely affecting, and in many instances, improving the ball's playability (hardness/softness) and/or durability (i.e., cut resistance, fatigue resistance, etc.) characteristics.

These and other objects and features of the invention will be apparent from the following detailed description.

Brief Description of the Drawings

FIG. 1 is a cross-sectional view of a golf ball embodying the invention illustrating a core 10 and a cover 12 consisting of an inner layer 14 and an outer layer 16 having dimples 18; and

FIG. 2 is a diametrical cross-sectional view of a golf ball of the invention having a core 10 and a cover 12 made of an inner layer 14 and an outer layer 16 having dimple 18.

Detailed Description of the Invention

The present invention relates to improved multi-layer golf balls, particularly a golf ball comprising a multi-layered cover 12 over a solid core 10, and method for making same.

The multi-layered cover 12 comprises two layers: a first or inner layer or ply 14 and a second or outer layer or ply 16. The inner layer 14 is comprised of a low acid (i.e. 16 weight percent acid or less) ionomer blend. Preferably, the inner layer is comprised of a blend of two or more low acid (i.e. 16 weight percent acid or less) ionomer resins neutralized to various extents by different metal cations. The inner cover layer may or may not include a metal stearate (e.g., zinc stearate) or other metal fatty acid salt. The purpose of the metal stearate or other metal fatty acid salt is to lower the cost of production without affecting the overall performance of the finished golf ball.

The low acid ionomers which may be suitable for use in formulating the inner layer compositions of the subject invention are ionic copolymers which are the metal, i.e., sodium, zinc,

magnesium, etc., salts of the reaction product of an olefin having from about 2 to 8 carbon atoms and an unsaturated monocarboxylic acid having from about 3 to 8 carbon atoms. Preferably, the ionomeric resins are copolymers of ethylene and either acrylic or methacrylic acid. In some circumstances, an additional comonomer such as an acrylate ester (i.e., iso- or n-butylacrylate, etc.) can also be included to produce a softer terpolymer. The carboxylic acid groups of the copolymer are partially neutralized (i.e., approximately 10-75%, preferably 30-70%) by the metal ions. Each of the low acid ionomer resins which may be included in the inner layer cover compositions of the invention contains 16% by weight or less of a carboxylic acid.

The inner layer compositions include the low acid ionomers such as those developed and sold by E. I. DuPont de Nemours & Company under the trademark "Surlyn®" and by Exxon Corporation under the trademark "Escor®" or tradename "Iotek", or blends thereof.

The low acid ionomeric resins available from Exxon under the designation "Escor®" and or "Iotek", are somewhat similar to the low acid ionomeric resins available under the "Surlyn®" trademark. However, since the Escor®/Iotek ionomeric resins are sodium or zinc salts of poly(ethylene-acrylic acid) and the "Surlyn®" resins are zinc, sodium, magnesium, etc. salts of poly(ethylene-methacrylic acid), distinct differences in properties exist.

When utilized in the construction of the inner layer of a multi-layered golf ball, it has been found that the low acid ionomer blends extend the range of compression and spin rates beyond that previously obtainable. More preferably, it has been found that when two or more low acid ionomers, particularly blends of sodium and zinc high acid ionomers, are processed to produce the covers of multi-layered golf balls, (i.e., the inner cover layer herein) the resulting golf balls will travel further and at an enhanced spin rate than previously known multi-layered golf balls. Such an improvement is particularly noticeable in enlarged or oversized golf balls.

For example, the normal size, multi-layer golf ball taught in 4,650,193 does not incorporate blends of low acid ionomeric resins of the present invention in the inner cover layer. In addition, the multi-layered ball disclosed in the '193 patent suffers substantially in durability in comparison with the present invention.

Furthermore, as shown in the Examples, use of a inner layer formulated from blends of lower acid ionomers produces multi-layer golf balls having enhanced compression and spin rates. These are the properties desired by the more skilled golfer.

With respect to the outer layer 16 of the multi-layered cover of the present invention, the outer cover layer is comparatively softer than the low acid ionomer blend based inner layer. The softness provides for the enhanced feel and playability characteristics typically associated with balata or balata-blend

balls. The outer layer or ply is comprised of a relatively soft, low modulus (about 1,000 psi to about 10,000 psi) and low acid (less than 16 weight percent acid) ionomer, ionomer blend or a non-ionomeric elastomer such as, but not limited to, a polyurethane, a polyester elastomer such as that marketed by DuPont under the trademark Hytrel®, a polyurethane sold by BASF under the designation Baytec® or a polyester amide such as that marketed by Elf Atochem S.A. under the trademark Pebax®. The outer layer is fairly thin (i.e. from about 0.010 to about 0.070 in thickness, more desirably 0.03 to 0.06 inches in thickness for a 1.680 inch ball and 0.04 to 0.07 inches in thickness for a 1.72 inch ball), but thick enough to achieve desired playability characteristics while minimizing expense.

Preferably, the outer layer includes a blend of hard and soft (low acid) ionomer resins such as those described in U. S. Patent Nos. 4,884,814 and 5,120,791, both incorporated herein by reference. Specifically, a desirable material for use in molding the outer layer comprises a blend of a high modulus (hard), low acid, ionomer with a low modulus (soft), low acid, ionomer to form a base ionomer mixture. A high modulus ionomer herein is one which measures from about 15,000 to about 70,000 psi as measured in accordance with ASTM method D-790. The hardness may be defined as at least 50 on the Shore D scale as measured in accordance with ASTM method D-2240.

A low modulus ionomer suitable for use in the outer layer blend has a flexural modulus measuring from about 1,000 to about

10,000 psi, with a hardness of about 20 to about 40 on the Shore D scale.

The hard ionomer resins utilized to produce the outer cover layer composition hard/soft blends include ionic copolymers which are the sodium, zinc, magnesium or lithium salts of the reaction product of an olefin having from 2 to 8 carbon atoms and an unsaturated monocarboxylic acid having from 3 to 8 carbon atoms. The carboxylic acid groups of the copolymer may be totally or partially (i.e. approximately 15-75 percent) neutralized.

The hard ionomeric resins are likely copolymers of ethylene and either acrylic and/or methacrylic acid, with copolymers of ethylene and acrylic acid being the most preferred. Two or more types of hard ionomeric resins may be blended into the outer cover layer compositions in order to produce the desired properties of the resulting golf balls.

As discussed earlier herein, the hard ionomeric resins introduced under the designation Escor® and sold under the designation "Iotek" are somewhat similar to the hard ionomeric resins sold under the Surlyn® trademark. However, since the "Iotek" ionomeric resins are sodium or zinc salts of poly(ethylene-acrylic acid) and the Surlyn® resins are zinc or sodium salts of poly(ethylene-methacrylic acid) some distinct differences in properties exist. As more specifically indicated in the data set forth below, the hard "Iotek" resins (i.e., the acrylic acid based hard ionomer resins) are the more preferred hard resins for use in formulating the outer layer blends for use in the present

invention. In addition, various blends of "Iotek" and Surlyn® hard ionomeric resins, as well as other available ionomeric resins, may be utilized in the present invention in a similar manner.

Examples of commercially available hard ionomeric resins which may be used in the present invention in formulating the inner and outer cover blends include the hard sodium ionic copolymer sold under the trademark Surlyn®8940 and the hard zinc ionic copolymer sold under the trademark Surlyn®9910. Surlyn®8940 is a copolymer of ethylene with methacrylic acid and about 15 weight percent acid which is about 29 percent neutralized with sodium ions. This resin has an average melt flow index of about 2.8. Surlyn®9910 is a copolymer of ethylene and methacrylic acid with about 15 weight percent acid which is about 58 percent neutralized with zinc ions. The average melt flow index of Surlyn®9910 is about 0.7. The typical properties of Surlyn®9910 and 8940 are set forth below in Table 1:

TABLE 1

Typical Properties of Commercially Available Hard
Surlyn® Resins Suitable for Use in the Inner and Outer Layer
Blends of the Present Invention

	<u>ASTM D</u>	<u>8940</u>	<u>9910</u>	<u>8920</u>	<u>8528</u>	<u>9970</u>	<u>9730</u>
Cation Type		Sodium	Zinc	Sodium	Sodium	Zinc	Zinc
Melt flow index, gms/10 min.	D-1238	2.8	0.7	0.9	1.3	14.0	1.6
Specific Gravity, g/cm ³	D-792	0.95	0.97	0.95	0.94	0.95	0.95
Hardness, Shore D	D-2240	66	64	66	60	62	63
Tensile Strength, (kpsi), MPa	D-638	(4.8) 33.1	(3.6) 24.8	(5.4) 37.2	(4.2) 29.0	(3.2) 22.0	(4.1) 28.0

Elongation, %	D-638	470	290	350	450	460	460
Flexural Modulus, (kpsi) MPa	D-790	(51) 350	(48) 330	(55) 380	(32) 220	(28) 190	(30) 210
Tensile Impact (23°C) KJ/m, (ft.-lbs./in ²)	D-1822S	1020 (485)	1020 (485)	865 (410)	1160 (550)	760 (360)	1240 (590)
Vicat Temperature, °C	D-1525	63	62	58	73	61	73

Examples of the more pertinent acrylic acid based hard ionomer resin suitable for use in the present inner and outer cover composition sold under the "Iotek" tradename by the Exxon Corporation include Iotek 4000, Iotek 4010, Iotek 8000, Iotek 8020 and Iotek 8030. The typical properties of these and other Iotek hard ionomers suited for use in formulating the inner and outer layer cover compositions are set forth below in Table 2:

TABLE 2

Typical Properties of Iotek Ionomers

Resin Properties	ASTM Method	Units	4000	4010	8000	8020	8030
Cation type			zinc	zinc	sodium	sodium	sodium
Melt index	D-1238	g/10 min.	2.5	1.5	0.8	1.6	2.8
Density	D-1505	kg/m ³	963	963	954	960	960
Melting Point	D-3417	°C	90	90	90	87.5	87.5
Crystallization Point	D-3417	°C	62	64	56	53	55
Vicat Softening Point	D-1525	°C	62	63	61	64	67
% Weight Acrylic Acid			16		11		
% of Acid Groups cation neutralized			30		40		
Plaque Properties (3 mm thick, compression molded)	ASTM Method	Units	4000	4010	8000	8020	8030
Tensile at break	D-638	MPa	24	26	36	31.5	28
Yield point	D-638	MPa	none	none	21	21	23
Elongation at break	D-638	%	395	420	350	410	395
1% Secant modulus	D-638	MPa	160	160	300	350	390
Shore Hardness D	D-2240	--	55	55	61	58	59
Film Properties (50 micron film 2.2:1 Blow-up ratio)			4000	4010	8000	8020	8030
Tensile at Break MD	D-882	MPa	41	39	42	52	47.4
TD	D-882	MPa	37	38	38	38	40.5
Yield point MD	D-882	MPa	15	17	17	23	21.6
TD	D-882	MPa	14	15	15	21	20.7
Elongation at Break MD	D-882	%	310	270	260	295	305
TD	D-882	%	360	340	280	340	345
1% Secant modulus MD	D-882	MPa	210	215	390	380	380
TD	D-882	MPa	200	225	380	350	345
Dart Drop Impact	D-1709	g/micron	12.4	12.5	20.3		

<u>Resin Properties</u>	<u>ASTM Method</u>	<u>Units</u>	<u>7010</u>	<u>7020</u>	<u>7030</u>
Cation type			zinc	zinc	zinc
Melt Index	D-1238	g/10 min.	0.8	1.5	2.5
Density	D-1505	kg/m ³	960	960	960
Melting Point	D-3417	°C	90	90	90
Crystallization Point	D-3417	°C	--	--	--
Vicat Softening Point	D-1525	°C	60	63	62.5
%Weight Acrylic Acid			--	--	--
% of Acid Groups Cation Neutralized			--	--	--

<u>Plaque Properties</u> (3 mm thick, compression molded)	<u>ASTM Method</u>	<u>Units</u>	<u>7010</u>	<u>7020</u>	<u>7030</u>
Tensile at break	D-638	MPa	38	38	38
Yield Point	D-638	MPa	none	none	none
Elongation at break	D-638	%	500	420	395
1% Secant modulus	D-638	MPa	--	--	--
Shore Hardness D	D-2240	--	57	55	55

Comparatively, soft ionomers are used in formulating the hard/soft blends of the inner and outer cover compositions. These ionomers include acrylic acid based soft ionomers. They are generally characterized as comprising sodium or zinc salts of a terpolymer of an olefin having from about 2 to 8 carbon atoms, acrylic acid, and an unsaturated monomer of the acrylate ester class having from 1 to 21 carbon atoms. The soft ionomer is preferably a zinc based ionomer made from an acrylic acid base polymer in an unsaturated monomer of the acrylate ester class. The soft (low modulus) ionomers have a hardness from about 20 to about 40 as measured on the Shore D scale and a flexural modulus from about 1,000 to about 10,000, as measured in accordance with ASTM method D-790.

Certain ethylene-acrylic acid based soft ionomer resins developed by the Exxon Corporation under the designation "Iotek 7520" (referred to experimentally by differences in neutralization and melt indexes as LDX 195, LDX 196, LDX 218 and LDX 219) may be combined with known hard ionomers such as those indicated above to produce the inner and outer cover layers. The combination produces higher C.O.R.s at equal or softer hardness, higher melt flow (which corresponds to improved, more efficient molding, i.e., fewer rejects) as well as significant cost savings versus the inner and outer layers of multi-layer balls produced by other known hard-soft ionomer blends as a result of the lower overall raw materials costs and improved yields.

While the exact chemical composition of the resins to be sold by Exxon under the designation Iotek 7520 is considered by Exxon to be confidential and proprietary information, Exxon's experimental product data sheet lists the following physical properties of the ethylene acrylic acid zinc ionomer developed by Exxon:

TABLE 3

Physical Properties of Iotek 7520

	<u>Property</u>	<u>ASTM Method</u>	<u>Units</u>	<u>Typical Value</u>
	Melt Index	D-1238	g/10 min.	2
5	Density	D-1505	kg/m ³	0.962
	Cation			Zinc
	Melting Point	D-3417	°C	66
	Crystallization Point	D-3417	°C	49
10	Vicat Softening Point	D-1525	°C	42

Plaque Properties (2 mm thick Compression Molded Plaques)

	Tensile at Break	D-638	MPa	10
	Yield Point	D-638	MPa	None
15	Elongation at Break	D-638	%	760
	1% Secant Modulus	D-638	MPa	22
	Shore D Hardness	D-2240		32
	Flexural Modulus	D-790	MPa	26
	Zwick Rebond	ISO 4862	%	52
20	De Mattia Flex Resistance	D-430	Cycles	>5000

In addition, test data collected by the inventor indicates that Iotek 7520 resins have Shore D hardnesses of about 32 to 36 (per ASTM D-2240), melt flow indexes of 3 ± 0.5 g/10 min (at 190°C. per ASTM D-1288), and a flexural modulus of about 2500-3500 psi (per ASTM D-790). Furthermore, testing by an independent

testing laboratory by pyrolysis mass spectrometry indicates that Iotek 7520 resins are generally zinc salts of a terpolymer of ethylene, acrylic acid, and methyl acrylate.

Furthermore, the inventor has found that a newly developed grade of an acrylic acid based soft ionomer available from the Exxon Corporation under the designation Iotek 7510, is also effective, when combined with the hard ionomers indicated above in producing golf ball covers exhibiting higher C.O.R. values at equal or softer hardness than those produced by known hard-soft ionomer blends. In this regard, Iotek 7510 has the advantages (i.e. improved flow, higher C.O.R. values at equal hardness, increased clarity, etc.) produced by the Iotek 7520 resin when compared to the methacrylic acid base soft ionomers known in the art (such as the Surlyn 8625 and the Surlyn 8629 combinations disclosed in U.S. Patent No. 4,884,814).

In addition, Iotek 7510, when compared to Iotek 7520, produces slightly higher C.O.R. values at equal softness/hardness due to the Iotek 7510's higher hardness and neutralization. Similarly, Iotek 7510 produces better release properties (from the mold cavities) due to its slightly higher stiffness and lower flow rate than Iotek 7520. This is important in production where the soft covered balls tend to have lower yields caused by sticking in the molds and subsequent punched pin marks from the knockouts.

According to Exxon, Iotek 7510 is of similar chemical composition as Iotek 7520 (i.e. a zinc salt of a terpolymer of ethylene, acrylic acid, and methyl acrylate) but is more highly

neutralized. Based upon FTIR analysis, Iotek 7520 is estimated to be about 30-40 wt.-% neutralized and Iotek 7510 is estimated to be about 40-60 wt.-% neutralized. The typical properties of Iotek 7510 in comparison of those of Iotek 7520 are set forth below:

TABLE 4

Physical Properties of Iotek 7510
in Comparison to Iotek 7520

	<u>IOTEK 7520</u>	<u>IOTEK 7510</u>
MI, g/10 min	2.0	0.8
10 Density, g/cc	0.96	0.97
15 Melting Point, °F	151	149
Vicat Softening Point, °F	108	109
Flex Modulus, psi	3800	5300
Tensile Strength, psi	1450	1750
15 Elongation, %	760	690
Hardness, Shore D	32	35

It has been determined that when hard/soft ionomer blends are used for the outer cover layer, good results are achieved when the relative combination is in a range of about 90 to about 10 percent hard ionomer and about 10 to about 90 percent soft ionomer. The results are improved by adjusting the range to about 75 to 25 percent hard ionomer and 25 to 75 percent soft ionomer. Even better results are noted at relative ranges of about 60 to 90 percent hard ionomer resin and about 40 to 60 percent soft ionomer resin.

Specific formulations which may be used in the cover composition are included in the examples set forth in U. S. Patent No. 5,120,791 and 4,884,814. The present invention is in no way limited to those examples.

Moreover, in alternative embodiments, the outer cover layer formulation may also comprise a soft, low modulus non-ionomeric thermoplastic elastomer including a polyester polyurethane such as B.F.Goodrich Company's Estane® polyester polyurethane X-4517. According to B.F.Goodrich, Estane® X-4517 has the following properties:

Properties of Estane® X-4517

Tensile	1430
100%	815
200%	1024
300%	1193
Elongation	641
Youngs Modulus	1826
Hardness A/D	88/39
Dayshore Rebound	59
Solubility in Water	Insoluble
Melt processing temperature	>350°F (>177°C)
Specific Gravity (H ₂ O=1)	1.1-1.3

DS B7 Other soft, relatively low modulus non-ionomeric thermoplastic elastomers may also be utilized to produce the outer cover layer as long as the non-ionomeric thermoplastic elastomers produce the playability and durability characteristics desired without adversely effecting the enhanced spin characteristics produced by the low acid ionomer resin compositions. These include, but are not limited to thermoplastic polyurethanes such

as: Texin thermoplastic polyurethanes from Mobay Chemical Co. and the Pellethane thermoplastic polyurethanes from Dow Chemical Co.; Ionomer/rubber blends such as those in Spalding U.S. Patents 4,986,545; 5,098,105 and 5,187,013; and, Hytrel polyester elastomers from DuPont and Pebax polyesteramides from Elf Atochem S.A.

Similarly, a castable, thermosetting polyurethane produced by BASF under the trade designation Baytec® has also shown enhanced cover formulation properties. According to BASF, Baytec® (such as Baytec® RE 832), relates to a group of reactive elastomers having outstanding wear resistance, high mechanical strength, high elasticity and good resistance to weathering, moisture and chemicals. The Baytec® RE-832 system gives the following typical physical properties:

<u>Property</u>	<u>ASTM Test Method</u>	<u>Unit</u>	<u>Value</u>
Tear Strength	D624	pli	180
Die C			
Stress at			
100% Modulus	D412	psi	320
200% Modulus			460
300% Modulus			600
Ultimate Strength	D412	psi	900
Elongation at Break	D412	%	490
Taber Abrasion	D460, H-18	mg/1000 cycles	350

<u>Component¹ Properties</u>	<u>Part A (Isocyanate)</u>	<u>Part B (Resin)</u>
Viscosity @ 25°C, mPa·s	2500	2100
Density @ 25°C, g/cm	1.08	1.09
NCO, %	9.80	—
5 Hydroxyl Number, Mg KOH/g	—	88

¹Component A is a modified diphenylmethane diisocyanate (MDI) prepolymer and component B is a polyether polyol blend.

10 In preparing golf balls in accordance with the present invention, a hard inner cover layer is molded (by injection molding or by compression molding) about a core (preferably a solid core). A comparatively softer outer layer is molded over the inner layer.

15 The conventional solid core is about 1.545 inches in diameter, although it can range from about 1.495 to about 1.575 inches. Conventional solid cores are typically compression molded from a slug of uncured or lightly cured elastomer composition comprising a high cis content polybutadiene and a metal salt of an α , β , ethylenically unsaturated carboxylic acid such as zinc mono or diacrylate or methacrylate. To achieve higher coefficients of
20 restitution in the core, the manufacturer may include fillers such as small amounts of a metal oxide such as zinc oxide. In addition, larger amounts of metal oxide than those that are needed to achieve the desired coefficient are often included in conventional cores in order to increase the core weight so that the finished ball more
25 closely approaches the U.S.G.A. upper weight limit of 1.620 ounces. Other materials may be used in the core composition including compatible rubbers or ionomers, and low molecular weight fatty

acids such as stearic acid. Free radical initiators such as peroxides are admixed with the core composition so that on the application of heat and pressure, a complex curing cross-linking reaction takes place.

5 The inner cover layer which is molded over the core is about 0.100 inches to about 0.010 inches in thickness, preferably about 0.0375 inches thick. The outer cover layer is about 0.010 inches to about 0.050 inches in thickness, preferably 0.0300 inches thick. Together, the core, the inner cover layer and the outer
10 cover layer combine to form a ball having a diameter of 1.680 inches or more, the minimum diameter permitted by the rules of the United States Golf Association and weighing about 1.620 ounces.

 Additional materials may be added to the cover compositions (both inner and outer cover layer) of the present
15 invention including dyes (for example, Ultramarine Blue sold by Whitaker, Clark and Daniels of South Plainsfield, N.J.) (see U.S. Patent No. 4,679,795); pigments such as titanium dioxide, zinc oxide, barium sulfate and zinc sulfate; and UV absorbers; antioxidants; antistatic agents; and stabilizers. Further, the
20 cover compositions of the present invention may also contain softening agents, such as plasticizers, processing aids, etc. and reinforcing material such as glass fibers and inorganic fillers, as long as the desired properties produced by the golf ball covers are not impaired.

The various cover composition layers of the present invention may be produced according to conventional melt blending procedures. In the case of the outer cover layer, when a blend of hard and soft, low acid ionomer resins are utilized, the hard ionomer resins are blended with the soft ionomeric resins and with a masterbatch containing the desired additives in a Banbury mixer, two-roll mill, or extruder prior to molding. The blended composition is then formed into slabs and maintained in such a state until molding is desired. Alternatively, a simple dry blend of the pelletized or granulated resins and color masterbatch may be prepared and fed directly into the injection molding machine where homogenization occurs in the mixing section of the barrel prior to injection into the mold. If necessary, further additives such as an inorganic filler, etc., may be added and uniformly mixed before initiation of the molding process. A similar process is utilized to formulate the low acid ionomer resin compositions used to produce the inner cover layer.

The golf balls of the present invention can be produced by molding processes currently well known in the golf ball art. Specifically, the golf balls can be produced by injection molding or compression molding the inner cover layer about wound or solid molded cores to produce an intermediate golf ball having a diameter of about 1.50 to 1.67 inches, preferably about 1.620 inches. The outer layer is subsequently molded over the inner layer to produce a golf ball having a diameter of 1.680 inches or more. Although either solid cores or wound cores can be used in the present

invention, as a result of their lower cost and superior performance, solid molded cores are preferred over wound cores.

5 In compression molding, the inner cover composition is formed via injection at about 380°F to about 450°F into smooth surfaced hemispherical shells which are then positioned around the core in a mold having the desired inner cover thickness and subjected to compression molding at 200° to 300°F for about 2 to 10 minutes, followed by cooling at 50° to 70°F for about 2 to 7 minutes to fuse the shells together to form a unitary intermediate ball. In addition, the intermediate balls may be produced by injection molding wherein the inner cover layer is injected directly around the core placed at the center of an intermediate ball mold for a period of time in a mold temperature of from 50°F to about 100°F. Subsequently, the outer cover layer is molded about the core and the inner layer by similar compression or injection molding techniques to form a dimpled golf ball of a diameter of 1.680 inches or more.

10 After molding, the golf balls produced may undergo various further processing steps such as buffing, painting and marking as disclosed in U.S. Patent No. 4,911,451.

15 The resulting golf ball produced from the low acid ionomer resin inner layer and the relatively softer, low flexural modulus outer layer provide for an improved multi-layer golf ball which provides for desirable coefficient of restitution, compression, spin and durability properties while at the same time

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offering the feel characteristics associated with soft balata and balata-like covers of the prior art.

The present invention is further illustrated by the following examples in which the parts of the specific ingredients are by weight. It is to be understood that the present invention is not limited to the examples, and various changes and modifications may be made in the invention without departing from the spirit and scope thereof.

Example 1

Several intermediate balls (cores plus inner cover layers) were prepared in accordance with conventional molding procedures described above. The inner cover compositions were molded around 1.545 inch diameter cores weighing 36.5 grams such that the inner cover had a wall thickness of about 0.0675 inches, with the overall ball measuring about 1.680 inches in diameter.

The cores utilized in the examples were comprised of the following ingredients: high cis-polybutadiene, zinc diacrylate, zinc oxide, zinc stearate, peroxide, calcium carbonate, etc. The molded cores exhibited Riehle compressions of about 60 and C.O.R. values of about .800. A representative formulation of the molded cores is set forth below:

	<u>MATERIAL</u>	<u>WEIGHT</u>
	BR-1220 (high cis-polybutadiene)	70.70
	Taktene 220 (high cis-polybutadiene)	29.30
	React Rite ZDA (zinc diacrylate)	31.14
5	Zinc Oxide	6.23
	Zinc Stearate	20.15
	Limestone	17.58
	Ground Flash	20.15
	(20-40 Mesh)	
10	Blue Masterbatch	.012
	Luperco 231XL	
	or Trigonox 29/40	.89
	Papi 94	.50

Blue Masterbatch consists of unknown compositions used only for internal identification purposes and has no effect on physical properties.

The inner cover compositions designated herein as compositions A-E utilized to formulate the intermediate balls are set forth in Table 7 below. The resulting molded intermediate balls were tested to determine the individual compression (Riehle), C.O.R., Shore C hardness, spin rate and cut resistance properties. These results are also set forth in Table 7 below.

The data of these examples are the average of twelve intermediate balls produced for each example. The properties were measured according to the following parameters:

Coefficient of restitution (C.O.R.) was measured by firing the resulting golf ball in an air canon at a velocity of 125 feet per second against a steel plate positioned 12 feet from the muzzle of the canon. The rebound velocity was then measured. The rebound velocity was divided by the forward velocity to give a coefficient of restitution.

Shore hardness was measured in accordance with ASTM test 2240.

5 Cut resistance was measured in accordance with the following procedure: A golf ball is fired at 135 feet per second against the leading edge of a pitching wedge wherein the leading edge radius is 1/32 inch, the loft angle is 51 degrees, the sole radius is 2.5 inches and the bounce angle is 7 degrees.

10 The cut resistance of the balls tested herein was evaluated on a scale of 1 to 5. The number 1 represents a cut that extends completely through the cover to the core. A 2 represents a cut that does not extend completely through the cover but that does break the surface. A 3 does not break the surface of the cover but does leave a permanent dent. A 4 leaves only a slight crease which is permanent but not as severe as 3. A 5 represents virtually no visible indentation or damage of any sort.

15 The spin rate of the golf ball was measured by striking the resulting golf balls with a pitching wedge or 9 iron wherein the club head speed is about 105 feet per second and the ball is launched at an angle of 26 to 34 degrees with an initial velocity of about 110 to 115 feet per second. The spin rate was measured by observing the rotation of the ball in flight using stop action Strobe photography.

20 Initial velocity is the velocity of a ball when struck at a hammer speed of 143.8 feet per second in accordance with a test as prescribed by the U.S.G.A.

25 As will be noted, compositions A, B and C include high acid ionomeric resins (16% or more acid), with composition B further including zinc stearate. Composition D represents the inner layer (i.e. Surlyn 1605) used in U.S. Patent No. 4,431,193. Composition E provides a hard, low acid ionomeric resin blend.

30 The purpose behind producing and testing the balls of Table 5 was to provide a subsequent comparison in properties with the multi-layer golf balls of the present invention.

Table 5

Molded Intermediate Golf BallsIngredients ofInner Cover Compositions

	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
5 Iotek 959	50	50	--	--	--
Iotek 960	50	50	--	--	--
Zinc Stearate	--	50	--	--	--
Surlyn 8162	--	--	75	--	--
Surlyn 8422	--	--	25	--	--
Surlyn 1605	--	--	--	100	--
10 Iotek 7030	--	--	--	--	50
Iotek 8000	--	--	--	--	50

Properties of Molded
Intermediate Balls

	58	58	60	63	62
15 Compression					
C.O.R.	.811	.810	.807	.793	.801
Shore C Hardness	98	98	97	96	96
Spin Rate (R.P.M.)	7,367	6,250	7,903	8,337	7,956
Cut Resistance	4-5	4-5	4-5	4-5	4-5

As shown in Table 5 above, the high acid ionomer resin inner cover layer (molded intermediate balls A-C) have lower spin rates and exhibit higher resiliency characteristics than the low acid ionomer resin based inner cover layers of balls D and E.

Multi-layer balls in accordance with the present invention were then prepared. Specifically, the inner cover compositions used to produce intermediate golf balls from Table 5 were molded over the solid cores to a thickness of about 0.0375 inches, thus forming the inner layer. The diameter of the solid core with the inner layer measured about 1.620 inches. Alternatively, the intermediate golf balls of Table 5 were ground down using a centerless grinding machine to a size of 1.620 inches in diameter to produce an inner cover layer of 0.0375 inches.

The size of 1.620 inches was determined after attempting to mold the outer cover layer to various sizes (1.600", 1.610", 1.620", 1.630" and 1.640") of intermediate (core plus inner layer) balls. It was determined that 1.620" was about the largest "intermediate" ball (i.e., core plus inner layer) which could be easily molded over with the soft outer layer materials of choice. The goal herein was to use as thin an outer layer as necessary to achieve the desired playability characteristics while minimizing the cost of the more expensive outer materials. However, with a larger diameter final golf ball and/or if the cover is compression molded, a thinner cover becomes feasible.

With the above in mind, an outer cover layer composition was blended together in accordance with conventional blending techniques. The outer layer composition used for this portion of the example is a relatively soft cover composition such as those listed in U.S. Patent No. 5,120,791. An example of such a soft cover composition is a 45% soft/55% hard low acid ionomer blend designated by the inventor as "TE-90". The composition of TE-90 is set forth as follows:

Outer Cover Layer Composition TE-90

Iotek 8000	22.7 weight %
Iotek 7030	22.7 weight %
Iotek 7520	45.0 weight %
White MB ¹	9.6 weight %

¹White MB consists of about 23.77 weight percent TiO₂; 0.22 weight percent Uvitex OB, 0.03 weight percent Santonox R, 0.05 weight percent Ultramarine blue and 75.85 weight percent Iotek 7030.

The above outer layer composition was molded around each of the 1.620 diameter intermediate balls comprising a core plus one of compositions A-D, respectively. In addition, for comparison purposes, Surlyn® 1855 (new Surlyn® 9020), the cover composition of the '193 patent, was molded about the inner layer of composition D (the intermediate ball representative of the '193 patent). The outer layer TE-90 was molded to a thickness of approximately 0.030 inches to produce a golf ball of approximately 1.680 inches in diameter. The resulting balls (a dozen balls for each example) were tested and the various properties thereof are set forth in Table 6A as follows:

Table 6A
Finished Balls

<u>Ingredients:</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
Inner Cover Composition	A	B	C	D	D
Outer Cover Composition	TE-90	TE-90	TE-90	TE-90	Surlyn® 9020
<u>Properties of Molded Finished Balls:</u>					
Compression	63	63	69	70	61
C.O.R.	.784	.778	.780	.770	.757
Shore C Hardness	88	88	88	88	89
Spin (R.P.M.)	8,825	8,854	8,814	8,990	8,846
Cut Resistance	3-4	3-4	3-4	3-4	1-2

As it will be noted in finished balls 1-4, by creating a multi-layer cover utilizing the high acid ionomer resins in the inner cover layer and the hard/soft low acid ionomer resins in the outer cover layer, higher compression and increased spin rates are noted over the single layer covers of Table 5. In addition, both the C.O.R. and the Shore C hardness are reduced over the respective single layer covers of Table 5. This was once again particularly true with respect to the multi-layered balls containing the high acid ionomer resin in the inner layer (i.e. finished balls 1-4). In addition, with the exception of prior art ball 5 (i.e. the '193 patent), resistance to cutting remains good but is slightly decreased. As noted above, the prior art ball of the '193 patent suffers substantially in durability (as well as in resiliency) in comparison to the balls of the invention.

Furthermore, it is also noted that the use of the high acid ionomer resins as the inner cover material produces a substantial increase in the finished balls overall distance properties. In this regard, the high acid ionomer resin inner covers of balls 1-3 produce an increase of approximately 10 points in C.O.R. over the low acid ionomer resin inner covers of balls 4 and about a 25 point increase over the prior art balls 5. Since an increase in 3 to 6 points in C.O.R. results in an average increase of about 1 yard in distance, such an improvement is deemed to be significant.

Several other outer layer formulations were prepared and tested by molding them around the core and inner cover layer combination to form balls each having a diameter of about 1.68 inches. First, B.F. Goodrich Estane® X-4517 polyester polyurethane was molded about the core molded with inner layer cover formulation A. DuPont Surlyn® 9020 was molded about the core which was already molded with inner layer D. Similar properties tests were conducted on these golf balls and the results are set forth in Table 6B below:

Table 6BFinish Balls

	<u>Ingredients:</u>	<u>6</u>	<u>7</u>
5	Inner Cover Layer Composition	A	D
	Outer Cover Layer Composition	Estane® 4517	Surlyn® 9020
	<u>Properties of Molded Finished Balls:</u>		
10	Compression	67	61
	C.O.R.	.774	.757
	Shore C Hardness	74	89
	Spin (R.P.M.)	10,061	8,846
	Cut Resistance	3-4	1-2

15 The ball comprising inner layer formulation D and Surlyn® 9020 identifies the ball in the Nesbitt 4,431,193 patent. As is noted, the example provides for relatively high softness and spin rate though it suffers from poor cut resistance and low C.O.R. This ball is unacceptable by today's standards.

20 As for the Estane® X-4517 polyester polyurethane, a significant increase in spin rate over the TE-90 cover is noted along with an increased compression. However, the C.O.R. and Shore C values are reduced, while the cut resistance remains the same. Furthermore, both the Estane® X-4517 polyester polyurethane and the
25 Surlyn® 9020 were relatively difficult to mold in such thin sections.

Example 2

In order to analyze the change in characteristics produced by multi-layer golf balls (standard size) having inner cover layers comprised of ionomer resin blends of different acid
5 levels, a series of experiments were run. Specifically, 14 tests were performed, varying the type of core, inner cover layer and outer cover layer. The results are shown below:

Table 7

Sample #	CORE	INNER LAYER	THICKNESS	COMP/ COR	OUTER COVER	THICKNESS	COMP (Rhele)	COR	SHORE D	SPIN
5	8 1042 YELLOW	NONE	---	SEE BELOW	TOP GRADE	0.055"	61	.800	68	7331
	9 1042 YELLOW	NONE	---	SEE BELOW	959/960	0.055"	56	.808	73	6516
	10 SPECIAL 1.47"	959/960	0.050"	65/.805	959/960	0.055"	48	.830	73	6258
	11 1042 YELLOW	NONE	---	SEE BELOW	SD 90	0.055"	62	.792	63	8421
	12 SPECIAL 1.47"	TOP GRADE	0.050"	66/.799	SD 90	0.055"	55	.811	63	8265
10	13 SPECIAL 1.47"	959/960	0.050"	65/.805	SD 90	0.055"	53	.813	63	8254
	14 SPECIAL 1.47"	TOP GRADE	0.050"	66/.799	TOP GRADE	0.055"	51	.819	68	7390
	15 1042 YELLOW	NONE	---	SEE BELOW	Z-BALATA	0.055"	67	.782	55	9479
	16 SPECIAL 1.47"	959/960	0.050"	65/.805	Z-BALATA	0.055"	61	.800	55	9026
	17 SPECIAL 1.47"	TOP GRADE	0.050"	66/.799	Z-BALATA	0.055"	60	.798	55	9262
15	1042 YELLOW>COMP=72, COR=-.780 SPECIAL 1.47" CORE>COMP=57, COR=-.782									

In this regard, "Top Grade" or "TG" is a low acid inner cover ionomer resin blend comprising of 70.6% Iotek 8000, 19.9% Iotek 7010 and 9.6% white masterbatch. "959/960" is a 50/50 wt/wt blend of Iotek 959/960. In this regard, Escor® or Iotek 959 is a sodium ion neutralized ethylene-acrylic neutralized ethylene-acrylic acid copolymer. According to Exxon, Ioteks 959 and 960 contain from about 19.0 to about 21.0% by weight acrylic acid with approximately 30 to about 70 percent of the acid groups neutralized with sodium and zinc ions, respectively. The physical properties of these high acid acrylic acid based ionomers are as follows:

<u>PROPERTY</u>	<u>ESCOR® (IOTEK) 959</u>	<u>ESCOR® (IOTEK) 960</u>
Melt Index g/10 min	2.0	1.8
Cation	Sodium	Zinc
Melting Point, °F	172	174
Vicat Softening Point, °F	130	131
Tensile @ Break, psi	4600	3500
Elongation @ Break, %	325	430
Hardness, Shore D	66	57
Flexural Modulus, psi	66,000	27,000

Furthermore, the low acid ionomer formulation for "SD 90" and "Z-Balata" are set forth below:

<u>SD Cover</u>	<u>ZB Cover</u>
17.2% Surlyn 8320	19% Iotek 8000
7.5% Surlyn 8120	19% Iotek 7030
49% Surlyn 9910	52.5% Iotek 7520
16.4% Surlyn 8940	9.5% white MB
9.7% white MB	

The data clearly indicates that higher C.O.R. and hence increase travel distance can be obtained by using multi-layered covered balls versus balls covered with single layers. However, some sacrifices in compression and spin are also noted. Further, as shown in comparing Example Nos. 12 vs. 13, Example Nos. 17 vs. 16, etc., use of lower acid level inner cover layers and relatively soft outer cover layers (i.e., 50 wt. % or more soft ionomer) produces softer compression and higher spin rates than the golf balls comprised of high acid inner cover layers. Consequently, use of blends of low acid ionomer resins to produce the inner layer of a multi-layer covered golf ball, produces not only enhanced travel distance but also enhanced compression and spin properties.

Example 3

Multi-layer oversized golf balls were produced utilizing different ionomer resin blends as the inner cover layer (i.e., core plus inner cover layer is defined as "mantel"). The "ball data" of

the oversized multi-layer golf balls in comparison with production samples of "Top-Flite® XL" and "Top-Flite® Z-Balata" is set forth below.

Table 8

	<u>18</u>	<u>19</u>	<u>20</u>	<u>21</u> Top-Flite® XL	<u>22</u> Top-Flite® Z-Balata 90
<u>Core Data</u>					
Size	1.43	1.43	1.43	1.545	1.545
COR	.787	.787	.787	—	—
<u>Mantel Data</u>					
Material	TG	TG	TG	—	—
Size	.161	1.61	1.61	—	—
Thickness	.090	.090	.090	—	—
<u>Mantel Data</u> <u>(cont'd)</u>					
Shore D	68	68	68	—	—
Compression	57	57	57	—	—
COR	.815	.815	.815	—	—
<u>Ball Data</u>					
Cover	TG	ZB	SD	TG	ZB
Size	1.725	1.723	1.726	1.681	1.683
Weight	45.2	45.1	45.2	45.3	45.5
Shore D	68	56	63	68	56
Compression	45	55	49	53	77
COR	.820	.800	.810	.809	.797
Spin	7230	9268	8397	7133	9287

The results indicate that use of multi-layer covers enhances C.O.R. and travel distance. Further, the data shows that use of a blend of low acid ionomer resins (i.e., "Top Grade") to form the inner cover layer in combination with a soft outer cover

("ZB" or "SD") produces enhanced spin and compression characteristics. The overall combination results in a relatively optimal golf ball with respect to characteristics of travel distances, spin and durability.

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Example 4

Castable Polyurethane Covered Multi-layer Balls

A limited number of samples were made using BASF Baytec® RE232 polyurethane as a cover material over four different types of mantle cores. Controls included Z-Balata 100s along with the same mantle cores used for the polyurethane samples covered with Z-Balata cover stock. Mantle cores were made up of 82 and 58 compression cores covered with Iotek 8030/7030.

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Castable PU Molding Process

Materials used:

Baytec® RE832, mix ratio 9 parts A/12 parts B
 1 - 1.57" i.d. smooth cavity
 2 - 1.68" i.d. dimpled cavities
 1 - 2" hose clamp
 1 - bench vise or large C-clamp

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(The smooth and dimpled cavities are the same O.D.)

The mantle core is 1.57" and fits snugly in the 1.57" cavity. The hose clamp is attached to the 1.57" cavity and a mantle core is placed in inside. Urethane is mixed and poured into one of the dimpled cavities and the two halves are placed together and clamped, forcing out excess material and forming half the cover. The hose clamp is used to keep the two mold halves aligned

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during curing. When the cover material is set up enough (about 5 minutes), the two halves are separated and the 1.57" mold is replaced with the other 1.68" mold and the process is repeated. Both halves of the cover are now cast and the entire assemble is placed in an 125f oven for 1 hour after which it can be opened and the ball removed.

All samples were finished using normal production equipment and procedures. The properties of the finished balls are set forth below:

Table 2

	23	23	24	25	26	27	28	29
CORE DATA								
Size	1.47"	1.47"	1.47"	1.47"	1.47	1.47"	1.47"	1.47"
Weight	32.2	32	32.2	32	37.7	32.2	32	32.2
Comp	82	58	82	58	85	82	58	82
COR	768	772	768	772	794	768	772	768
MANTLE DATA								
Material	lotek	lotek	lotek	lotek		lotek	lotek	lotek
Weight	8030/7030	8030/7030	8030/7030	8030/7030	None	8030/7030	8030/7030	8030/7030
Size	37.8	38.1	37.9	38.1		37.8	38.1	37.9
Comp	1.57"	1.57"	1.57"	1.57"		1.57"	1.57"	1.57"
COR	70	48	69	48		70	48	69
	781	785	786	788		781	785	786
BALL DATA								
Cover Material	Baytec RE832	Baytec RE832	Baytec RE832	Baytec RE832	Z-Balata	Z-Balata	Z-Balata	Z-Balata
Weight	65.4	65.5	65.5	65.2	45.3	44.8	45	
Comp	75	64	73	60	80	66	50	65
COR	771	763	770	761	792	775	774	778
Shore C	65	65	65	65	84	84	84	84
Spin (rpm)	9560	8789	9285	8760	8796	8702	9072	8643
Cut (1-good, 4-poor)	2	2	2	1.5	2	2	2	2
Scuff (1-good, 4-poor)	1.5	1.5	1.5	1.5	2	3	3	3

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Table 9 contains the construction details and test results. Multilayer balls with the thermoset urethane covers (Examples 23-25) were softer in compression and similar in COR to the multi-layer balls with the Z-Balata cover (Examples 27-29). shore C was much lower for the urethane balls and they were more resistant to scuff than any of the Z-Balata covered balls. Guillotine cut resistance was about the same. Spin rate comparison shows that the urethane samples are better than the Z-Balata covered balls.

Test results indicate that a very good multi-layer ball can be made using castable polyurethane cover material. Further, advantages include the molding very thin covers, molding over very soft compression core/mantle, and low cost tooling.

The invention has been described with reference to the preferred embodiment. Obviously, modifications and alterations will occur to others upon reading and understanding the proceeding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

I claim:

1. A golf ball comprising:

a core;

an inner cover layer having a Shore D hardness of 60 or more molded on said core, the inner cover layer comprising a blend of two or more low acid ionomer resins containing no more than 16% by weight of an alpha, beta-unsaturated carboxylic acid; and

an outer cover layer having a Shore D hardness of 64 or less molded on said inner cover layer, said outer cover layer comprising a relatively soft polymeric material selected from the group consisting of non-ionomeric thermoplastic and thermosetting elastomers.

2. A golf ball according to claim 1, wherein the inner cover layer has a thickness of about 0.100 to about 0.010 inches and the outer cover layer has a thickness of about 0.010 to about 0.70 inches, the golf ball having an overall diameter of 1.680 inches or more.

3. A golf ball according to claim 1 wherein the inner cover layer has a thickness of about 0.050 inches and the outer cover layer has a thickness of about 0.055 inches, the golf ball having an overall diameter of 1.680 inches or more.

4. A golf ball according to claim 1 wherein the outer layer comprises a polyurethane based material.

5. A multi-layer golf ball comprising:

a spherical core;

5 an inner cover layer having a Shore D hardness of about 60 or more molded over said spherical core, said inner cover layer comprising an ionomeric resin including no more than 16% by weight of an alpha, beta-unsaturated carboxylic acid and having a modulus of from about 15,000 to about 70,000 psi;

1:0 an outer cover layer having a Shore D hardness of about 64 or less molded over said spherical intermediate ball to form a multi-layer golf ball, the outer layer comprising polyurethane based material.

6 ~~5~~ A multi-layer golf ball comprising:

a spherical core;

5 an inner cover layer molded over said spherical core to form a spherical intermediate ball, said inner cover layer comprising an ionomeric resin having no more than 16% by weight of an alpha, beta-unsaturated carboxylic acid and having a modulus of from about 15,000 to about 70,000 psi;

an outer cover layer molded over said spherical intermediate ball to form a multi-layer golf ball, the outer layer

10 comprising a non-ionomeric elastomer selected from the group consisting of polyester elastomer, polyester, polyether polyurethane and polyester amide, said outer cover layer having a modulus in a range of about 1,000 to about 30,000 psi.

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ABSTRACT

The present invention is directed to an improved multi-layer golf ball comprising a core, an inner cover layer and an outer cover layer. The inner cover layer is comprised of a low acid ionomer blend which may or may not include a filler such as zinc-stearate. The outer cover layer is comprised of a soft, non-ionomeric thermoplastic or thermosetting elastomer such as polyurethane, polyester or polyesteramide. The resulting multi-layered golf ball of the present invention provides for enhanced distance without sacrificing playability or durability when compared to known multi-layer golf balls.



Docket No.: P-3724-2/SLD 2 035-3-3

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am an original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled:

IMPROVED MULTI-LAYER GOLF BALL

the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37 Code of Federal Regulations § 1.56(a).

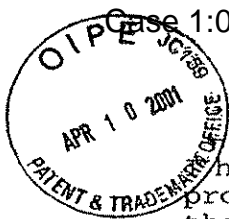
I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

None

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

None

CW 0308305



hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of : Sullivan
For : **IMPROVED MULTI-LAYER GOLF BALL**
Serial No. : Continuation of U.S. Serial No. 08/870,585
Filed : Herewith
Group Art Unit : 3711 (of parent)
Examiner : M. Graham (of parent)
Attorney Docket No. : P-3724-2-F1
(SLD 2 0035-3-3-1)

Cleveland, Ohio 44114-2518

Date: 4/10/2001

ASSOCIATE POWER OF ATTORNEY (37 CFR 1.34)

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Please recognize as Associate Attorneys in this case:

Diane F. Covello, Esq.
Reg. No. 34,164
Michelle Bugbee
Reg. No. 42,370
Spalding Sports Worldwide, Inc.
425 Meadow Street
PO Box 901
Chicopee, MA 01021-0901

Respectfully submitted,

FAY, SHARPE, FAGAN,
MINNICH & McKEE, LLP

Richard M. Klein
Reg. No. 33,000
Mark E. Bandy
Reg. No. 35,788
1100 Superior Avenue, Seventh Floor
Cleveland, Ohio 44114-2518
(216) 861-5582

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CW 0308307



UNITED STATES PATENT AND TRADEMARK OFFICE

COMMISSIONER FOR PATENTS
UNITED STATES PATENT AND TRADEMARK OFFICE
WASHINGTON, D.C. 20231
www.uspto.gov



Bib Data Sheet

CONFIRMATION NO. 2656

SERIAL NUMBER 09/832,154 ✓	FILING DATE 04/10/2001 ✓ RULE	CLASS 473	GROUP ART UNIT 3711	ATTORNEY DOCKET NO. P-3724-2-F1-C2
APPLICANTS Michael J. Sullivan, Barrington, RI;				
** CONTINUING DATA ***** THIS APPLICATION IS A CON OF 08/870,585 06/06/1997 <i>ABN</i> WHICH IS A CON OF 08/556,237 11/09/1995 ABN WHICH IS A CIP OF 08/542,793 10/13/1995 ABN WHICH IS A CIP OF 08/070,510 06/01/1993 ABN <i>Re 42602</i>				
** FOREIGN APPLICATIONS *****				
IF REQUIRED, FOREIGN FILING LICENSE <i>Re-9-26-02</i> GRANTED ** 04/26/2001				
Foreign Priority claimed <input type="checkbox"/> yes <input checked="" type="checkbox"/> no 35 USC 119 (a-d) conditions <input type="checkbox"/> yes <input checked="" type="checkbox"/> no <input type="checkbox"/> Met after met <i>Allowance</i>		STATE OR COUNTRY RI	SHEETS DRAWING 1	TOTAL CLAIMS 6
Verified and Acknowledged Examiner's Signature <i>[Signature]</i> Initials		INDEPENDENT CLAIMS 3		
ADDRESS Michelle Bugbee, Esq. Spalding Sports Worldwide, Inc. 425 Meadow Street PO Box 901 Chicopee, MA 10121-0901				
TITLE Multi layer golf ball				
FILING FEE RECEIVED 710	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		<input type="checkbox"/> All Fees <input type="checkbox"/> 1.16 Fees (Filing) <input type="checkbox"/> 1.17 Fees (Processing Ext. of time) <input checked="" type="checkbox"/> 1.18 Fees (Issue) <input type="checkbox"/> Other _____ <input type="checkbox"/> Credit	

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PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

4/13/2001 SSITHIB1 00000023 09832154

1 FC:101

710.00 DP

PTO-1556
(5/87)

*U.S. GPO: 2000-468-987/39595

CW 0308309

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 2000

Application or Docket Number

10-3724-2F1-02

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	6	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	6 minus 20 = *	
INDEPENDENT CLAIMS	3 minus 3 = *	
MULTIPLE DEPENDENT CLAIM PRESENT <input type="checkbox"/>		

* If the difference in column 1 is less than zero, enter "0" in column 2

SMALL ENTITY
TYPE ☐OR OTHER THAN
SMALL ENTITY

RATE	FEE		RATE	FEE
BASIC FEE	355.00	OR	BASIC FEE	710.00
X\$ 9=		OR	X\$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL		OR	TOTAL	710

CLAIMS AS AMENDED - PART II

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
	Total	Minus **	=
	Independent	Minus ***	=
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>		

SMALL ENTITY OR OTHER THAN
SMALL ENTITY

RATE	ADDI- TIONAL FEE		RATE	ADDI- TIONAL FEE
X\$ 9=		OR	X\$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
	Total	Minus **	=
	Independent	Minus ***	=
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>		

RATE	ADDI- TIONAL FEE		RATE	ADDI- TIONAL FEE
X\$ 9=		OR	X\$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

	(Column 1)	(Column 2)	(Column 3)
AMENDMENT C	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
	Total	Minus **	=
	Independent	Minus ***	=
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM <input type="checkbox"/>		

RATE	ADDI- TIONAL FEE		RATE	ADDI- TIONAL FEE
X\$ 9=		OR	X\$18=	
X40=		OR	X80=	
+135=		OR	+270=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20."

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

CLAIMS ONLY							SERIAL NO. 09832154	FILING DATE					
							APPLICANT(S)						
CLAIMS													
	AS FILED		AFTER 1st AMENDMENT		AFTER 2nd AMENDMENT			*		*		*	
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TOTAL IND.	3						TOTAL IND.						
TOTAL DEP.	3						TOTAL DEP.						
TOTAL CLAIMS	6						TOTAL CLAIMS						

* MAY BE USED FOR ADDITIONAL CLAIMS OR ADMENDMENTS

FORM PTO-2022 (1-88)

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

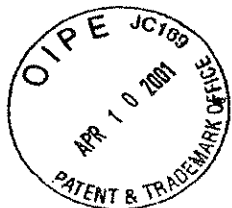
*U.S. Government Printing Office: 1988 - 433-214/70303

BEST AVAILABLE COPY

CW 0308311

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



IN RE APPLICATION OF : Sullivan
FOR : IMPROVED MULTI-LAYER
GOLF BALL
SERIAL NO. : ~~08/870,585~~ 09/852,154
FILED : June 6, 1997
ART UNIT : 3711
EXAMINER : M. Graham
LAST OFFICE ACTION : September 28, 2000
ATTORNEY DOCKET NO. : P-3724-2-F1
(SLD 2 0035-3-3-1)

Cleveland, Ohio 44114-2518
Date: 4/10/2001

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington D. C. 20231

Dear Sir:

Please amend the above-captioned application as follows:

CERTIFICATE OF EXPRESS MAIL

I hereby certify that this PRELIMINARY AMENDMENT is being deposited with the United States Postal Service by Express Mail Procedure in an envelope addressed to: Assistant Commissioner for Patents, Box Patent Application, Washington, D.C. 20231 on April 10, 2001.
Express Mailing Label No. EL545793944US.

Christina R. Correll
Christina R. Correll

A
CW 0308312

IN THE SPECIFICATION:

Please replace the paragraph starting on page 1, line 1 with the following rewritten paragraph:

a1
—This application is a continuation of U.S. Application Serial No. 08/870,585, filed on June 6, 1997, ^{now abandoned} which is a file wrapper continuing application of U.S. Application Serial No. 08/556,237, filed November 9, 1995, ^{now abandoned} which is a continuation-in-part of U.S. Application Serial No. 08/542,793 filed on October 13, 1995, ^{now abandoned} which is in turn a continuation-in-part of U.S. Application Serial No. 08/070,510 filed on June 1, 1993. ^{now abandoned} *see 9262*

IN THE CLAIMS:

Please amend the present claims as follows:

22
2. (Amended) A golf ball according to claim 1, wherein the inner cover layer has a thickness of about 0.100 to about 0.010 inches and the outer cover layer has a thickness of about 0.010 to about 0.070 inches, the golf ball having the properties required by the U.S.G.A. and having an overall diameter of 1.680 inches or more.

3. (Amended) A golf ball according to claim 1 wherein the inner cover layer has a thickness of about 0.050 inches and the outer cover layer has a thickness of about 0.055 inches, the golf ball having the properties required by the U.S.G.A. and having an overall diameter of 1.680 inches or more.

Sub B27
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6. (Amended) A multi-layer golf ball comprising:
a spherical core;
an inner cover layer molded over said spherical core to form a spherical intermediate ball, said inner cover layer comprising an ionomeric resin having no more than 16% by weight of an alpha, beta-unsaturated carboxylic acid and having a modulus of from about 15,000 to about 70,000 psi;

A2 cont

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an outer cover layer molded over said spherical intermediate ball to form a multi-layer golf ball, the outer layer comprising a non-ionomeric elastomer selected from the group consisting of polyester elastomer, polyester, polyether polyurethane and polyester amide, said outer cover layer having a modulus in a range of about 1,000 to about 30,000 psi.

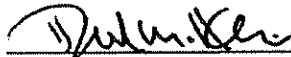
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REMARKS

Applicants respectfully request that the present amendments be entered. It is believed that the present amendments place the application in condition for allowance.

Respectfully Submitted,

FAY, SHARPE, FAGAN,
MINNICH & McKEE, LLP



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Reg. No. 33,000
Mark E. Bandy
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1100 Superior Avenue, 7th Floor
Cleveland, Ohio 44114-2518
(216) 861-5582

L:\DBC\DATA\MR\SLD20353.PLA

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The paragraph starting on page 1, line 1 has been replaced with the following paragraph:

--This application is a continuation of U.S. Application Serial No. 08/870,585, filed on June 6, 1997^{now abandoned}, which is a file wrapper continuing application of U.S. Application Serial No. 08/556,237, filed November 9, 1995, which is a continuation-in-part of U.S. Application Serial No. 08/542,793 filed on October 13, 1995^{now abandoned}, which is in turn a continuation-in-part of U.S. Application Serial No. 08/070,510 filed on June 1, 1993^{now abandoned}.



IN THE CLAIMS:

The present claims have been amended as follows:

2. (Amended) A golf ball according to claim 1, wherein the inner cover layer has a thickness of about 0.100 to about 0.010 inches and the outer cover layer has a thickness of about 0.010 to about [0.70] 0.070 inches, the golf ball having the properties required by the U.S.G.A. and having an overall diameter of 1.680 inches or more.

3. (Amended) A golf ball according to claim 1 wherein the inner cover layer has a thickness of about 0.050 inches and the outer cover layer has a thickness of about 0.055 inches, the golf ball having the properties required by the U.S.G.A. and having an overall diameter of 1.680 inches or more.

[8.] 6. (Amended) A multi-layer golf ball comprising:
a spherical core;

an inner cover layer molded over said spherical core to form a spherical intermediate ball, said inner cover layer comprising an ionomeric resin having no more than 16% by weight of an alpha, beta-unsaturated carboxylic acid and having a modulus of from about 15,000 to about 70,000 psi;

2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959	1958	1957	1956	1955	1954	1953	1952	1951	1950	1949	1948	1947	1946	1945	1944	1943	1942	1941	1940	1939	1938	1937	1936	1935	1934	1933	1932	1931	1930	1929	1928	1927	1926	1925	1924	1923	1922	1921	1920	1919	1918	1917	1916	1915	1914	1913	1912	1911	1910	1909	1908	1907	1906	1905	1904	1903	1902	1901	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891	1890	1889	1888	1887	1886	1885	1884	1883	1882	1881	1880	1879	1878	1877	1876	1875	1874	1873	1872	1871	1870	1869	1868	1867	1866	1865	1864	1863	1862	1861	1860	1859	1858	1857	1856	1855	1854	1853	1852	1851	1850	1849	1848	1847	1846	1845	1844	1843	1842	1841	1840	1839	1838	1837	1836	1835	1834	1833	1832	1831	1830	1829	1828	1827	1826	1825	1824	1823	1822	1821	1820	1819	1818	1817	1816	1815	1814	1813	1812	1811	1810	1809	1808	1807	1806	1805	1804	1803	1802	1801	1800	1799	1798	1797	1796	1795	1794	1793	1792	1791	1790	1789	1788	1787	1786	1785	1784	1783	1782	1781	1780	1779	1778	1777	1776	1775	1774	1773	1772	1771	1770	1769	1768	1767	1766	1765	1764	1763	1762	1761	1760	1759	1758	1757	1756	1755	1754	1753	1752	1751	1750	1749	1748	1747	1746	1745	1744	1743	1742	1741	1740	1739	1738	1737	1736	1735	1734	1733	1732	1731	1730	1729	1728	1727	1726	1725	1724	1723	1722	1721	1720	1719	1718	1717	1716	1715	1714	1713	1712	1711	1710	1709	1708	1707	1706	1705	1704	1703	1702	1701	1700	1699	1698	1697	1696	1695	1694	1693	1692	1691	1690	1689	1688	1687	1686	1685	1684	1683	1682	1681	1680	1679	1678	1677	1676	1675	1674	1673	1672	1671	1670	1669	1668	1667	1666	1665	1664	1663	1662	1661	1660	1659	1658	1657	1656	1655	1654	1653	1652	1651	1650	1649	1648	1647	1646	1645	1644	1643	1642	1641	1640	1639	1638	1637	1636	1635	1634	1633	1632	1631	1630	1629	1628	1627	1626	1625	1624	1623	1622	1621	1620	1619	1618	1617	1616	1615	1614	1613	1612	1611	1610	1609	1608	1607	1606	1605</
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APPLICATION DATA SHEET

Inventor Information

Inventor One Given Name:: Michael J.
Family Name:: Sullivan
Postal Address Line One:: 3 River Oak Road
Postal Address Line Two::
City:: Barrington
State or Province:: Rhode Island
Postal or Zip Code:: 02806
Citizenship Country:: United States

Correspondence Information

Name Line One:: Michelle Bugbee, Esq.
Address Line One:: Spalding Sports Worldwide, Inc.
Address Line Two:: 425 Meadow Street, PO Box 901
City:: Chicopee
State or Province:: MA
Postal or Zip Code:: 10121-0901
Telephone:: (413) 322-2985
Fax:: (413) 322-2575

Application Information

Title Line One:: IMPROVED MULTI LAYER GOLF BALL
Title Line Two::
Total Drawing Sheets:: 1
Formal Drawings?: Yes
Application Type:: Continuation

Representative Information

Registration Number:: Richard M. Klein (33,000)
Mark E. Bandy (35,788)

Continuity Information

This application is a:: Continuation
> Application One:: U.S. Serial No. 08/870,585
Filing Date:: June 6, 1997

This application is a:: File Wrapper Continuation
> Application Two:: U.S. Serial No. 08/556,237
Filing Date:: November 9, 1995

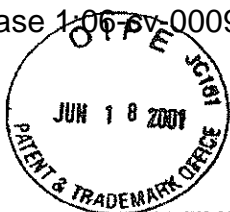
which is a:: Continuation-in-Part
>>> Application Four:: U.S. Serial No. 08/070,510
Filing Date:: June 1, 1993

Prior Foreign Applications

Foreign Application One::
Filing Date::
Country::
Priority Claimed:: (Y or N)

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PATENT

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of : Michael J. Sullivan
For : IMPROVED MULTI-LAYER GOLF BALL
Serial No. : 09/832,154
Filed : April 10, 2001
Group Art Unit : 3711
Customer No. : 24492
Attorney Docket No. : P-3724-2-F1-C2
(SLD 2 0035-3-3-1-1(II))

RECEIVED
JUN 20 2001
TECHNOLOGY CENTER R3700

Cleveland, Ohio 44114-2518
June 14, 2001

TRANSMITTAL SHEET

Assistant Commissioner for Patents
Washington, DC 20231

Dear Sir:

Enclosed for filing in the above-captioned application is a revised Data Sheet. This Supplemental Data Sheet corrects the correspondence address of Spalding Sports Worldwide, Inc. and adds a Customer Number for this application.

Please charge any deficiencies in fees which may be due to Deposit Account No. 06-0308.

CERTIFICATE OF MAILING

I hereby certify that this Correspondence and related papers are being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on June 14, 2001

By: Mary Ann Temesvari
Mary Ann Temesvari

CW 0308320

- 2 -

Respectfully Submitted,

FAY, SHARPE, FAGAN,
MINNICH & McKEE, LLP

A handwritten signature in black ink, appearing to read "Mark E. Bandy", is written over a horizontal line.

Richard M. Klein
Reg. No. 33,000
Mark E. Bandy
Reg. No. 35,788
1100 Superior Avenue, Suite 700
Cleveland, Ohio 44114-2518
(216) 861-5582

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